Application No.10/681,843
Am'ndt Dated: December 21, 2004

Listing of Claims:

Claim 1. (currently amended) A method for forming an electrical conductor, comprising:
forming electrically conductive segments;

forming a row of windows in a planar surface;

depositing electromigration-inhibiting material over the planar surface and into the windows to provide electro-migration inhibiting plugs in such windows;

said plugs interposed between and abutting neighboring electrically conductive segments to connect and space neighboring segments by a distance significantly less than the length of a segment; and

removing portions of either or both of said plugs and said conductive segments such that said plugs and conductive segments have a coplanar surface.

Claim 2.(previously presented) The method recited in claim 1, wherein each window is separated from a window next to it by a distance that is equal to or less than a predetermined critical length, L_c, selected to inhibit electromigration.

Claim 3. (previously presented) The method recited in claim 2, wherein the conductor has a length, L, that is greater than the critical length, L_c, and wherein the row includes a number of windows is equal to or more than (L/L_c)-l.

Claim 4. (previously presented) The method recited in claim 22 wherein the electrically conductive layer is patterned to form the electrically conductive segments connected by the plugs.

Claim 5. (previously presented) The method recited in claim 1[]], wherein the electrically conductive film segments comprise [[is a]] multi-layer structures including one or more layers of electromigration-inhibiting refractory materials.

Claims 6 - 8 (cancelled)

Claim 9. (previously presented) The method recited in claim 1 wherein the planar surface includes a dielectric layer having an electrical conductor disposed therein;

wherein the windows are formed in the electrical conductor thereby separating the electrical conductor into said plurality of electrically conductive segments;

wherein an electromigration-inhibiting material and [[/]] an electrically conductive material are successively deposited over the dielectric layer, over the electrical conductor and into the windows to provide, in such windows, said plugs;

wherein portions of the deposited electromigration-inhibiting and [[/]] electrically conductive materials are removed to form the plugs with surfaces co-planar with a surface of the dielectric layer and with surfaces of the electrically conductive segments.

Claim 10. (previously presented) The method recited in claim 1 wherein an electromigration-inhibiting liner and an electrically conductive material are deposited successively into the windows to form said plugs.

Claim 11. (previously presented) The method recited in claim 4 wherein an electromigration-inhibiting liner and an electrically conductive material are deposited successively into the windows to form said plugs.

Claims 12, 13 (Cancelled)

Claim 14. (previously presented) A method comprising:

providing a layer of electrically conductive material having a planar surface;

removing portions of the electrically conductive material to form a plurality of rows of spaced apart aligned windows in the planar surface of the electrically conductive layer;

forming electromigration-inhibiting plugs in the windows, a portion of such plugs extending beyond the planar surface;

removing the portion of the said plugs extending beyond the planar surface to form the plugs with electrically conductive segments of the electrically conductive material electrically interconnected through the plugs, said plugs and electrically conductive segments having coplanar surfaces and together forming an electrical conductor having a length L, greater than a critical length Lc selected to inhibit electromigration, and wherein each row of windows includes a number of windows equal to or more than (L/Lc)-1.

Claim 15. (previously presented) A method for forming a multiconductor metallization system with a minimum spacing between conductors less than one micron, the method comprising:

forming a plurality of equidistant rows of aligned windows in a [[the]] planar surface;

forming electromigration-inhibiting plugs in the windows extending beyond the planar surface;

removing the portion of the said plugs extending beyond the planar surface to form the plugs with surfaces co-planar with surfaces of said planar surface surrounding the plugs;

forming electrically conductive segments coplanar with the planar surface, abutting and electrically interconnecting the plugs, each said segment having a length in the range 100 – 300 microns and the plugs separating neighboring segments by no more than about one micron.

Claim 16. (previously presented) The method recited in claim 15, wherein the planar surface includes a dielectric layer having an electrical conductor disposed therein, and wherein the electrically conductive segments are formed by forming the windows in the electrical conductor.

Claim 17. (withdrawn)A multilevel metallization system, comprising:

a first metallization level of such system comprising: first electrical conductors having each a plurality of first electromigration-inhibiting/electrically conducting plugs therein, the first plugs having co-planar surfaces, the first electrical conductors comprising each a plurality of first electrically conductive segments electrically interconnected through the first plugs, the first electrically conductive segments being co-planar with each other and the first plugs;

electrically conductive vies passing through apertures in a dielectric layer disposed on the first metallization system to electrically *interconnect* the first metallization level and a second metallization level;

such second metallization system comprising:

electrical conductors having each a plurality of second electrically conductive segments electrically interconnected through a plurality of second electromigration-inhibiting/electrically conducting plugs, the second electrically conductive segments and the second plugs being co-planar.

Claim 18. (previously presented) A method of forming a multilevel metallization system, the method comprising:

forming a first metallization level including a plurality of first electrical conductors, each first electrical conductor having a plurality of spaced apart first electromigration-inhibiting plugs and a plurality of first electrically conductive segments electrically interconnected through ones of the first plugs, each of the first electrically conductive segments and the first plugs having coplanar surfaces, the first electrically conductive segments being formed of a different material than the first plugs and said first plugs separating neighboring first electrically conductive segments by distances significantly less than the length of a first electrically conductive segment;

forming a dielectric layer over the first metallization level;

forming electrically conductive vias passing through apertures in the [[a]] dielectric layer, forming a second metallization level over the dielectric layer, said vias electrically interconnecting the first metallization level and a second metallization level;

the second metallization level including a plurality of second electrical conductors, each of the second electrical conductors including a plurality of second electrically conductive segments separated by and electrically interconnected through a plurality of second electromigration-inhibiting plugs, the second electrically conductive segments and the second plugs having co-planar surfaces, the second electrically conductive segments being formed of a different material than the second plugs, and said second plugs separating neighboring second electrically conductive segments by distances significantly less than the length of a second electrically conductive segment.

Claims 19 – 21 (cancelled)

Claim 22. (previously presented) The method of claim 1, wherein said row of aligned windows is formed by providing an electrically conductive layer with a planar surface and removing portions of the electrically conductive layer to form said row of aligned windows in the planar surface of the electrically conductive layer, said electrically conductive segments defined by portions of said electrically conductive layer disposed between neighboring windows.

Claim 23 (previously presented) The method recited in claim 1, wherein each of said plugs comprises a liner of electro-migration inhibiting material filled with an electrically conductive material.

Claim 24. (previously presented) The method recited in claim 23, wherein the electro-migration inhibiting material comprises a refractory metal.

Claim 25. (previously presented) The method recited in claim 24, wherein the electro-migration inhibiting material comprises Ti, W, TiN, TiW, Mo or Ta.

Claim 26. (previously presented) The method recited in claim 1, wherein the electrically conductive segments comprise Al, CU, Au, or Ag or alloys thereof.

Claim 27. (previously presented) The method recited in claim 1, wherein the electrically conductive segments have lengths in the range 100 – 300 microns, and are spaced apart by said plugs by not more than about 1 micron.

Claim 28. (previously presented) The method as recited in claim 1, wherein said plugs are at least as wide as the widths of said electrically conductive segments.

Claim 29. (previously presented) A method for forming an electrical conductor having a length L, the electrical conductor including a plurality of electromigration-inhibiting plugs disposed between electrically conductive segments of the electrical conductor, comprising the steps of:

forming a row of aligned windows in a planar surface wherein neighboring ones of the windows are separated by at least a first distance and wherein the first distance is equal to or less than a critical length L_c, the critical length L_c being less than the length L and being selected to inhibit electromigration, and wherein the row includes a number of windows equal to or more than $(L/L_c)-1$;

depositing an electromigration-inhibiting material over the planar surface and through the windows to fill the windows and thereby provide, in such windows, plugs of electromigration-inhibiting material;

removing portions of the electromigration-inhibiting material to form the plugs with surfaces co-planar with a surface surrounding the plugs.

Claim 30. (previously presented) The method of claim 29 wherein the planar surface comprises a planar surface of an electrically conductive layer.

Claim 31. (previously presented) The method of claim 29 wherein the planar surface comprises a planar surface of a dielectric layer.

Claim 32. (previously presented) A method of forming a conductive region, the method comprising:

forming a conductive layer of a first electrically conductive material on an insulating layer overlying a semiconductor region, the conductive layer including a substantially planar surface;

forming a plurality of windows in the planar surface of the conductive layer extending to said insulating layer;

filling each of the windows with electro-migration inhibiting plugs such that each plug is abutted against neighboring portions of the conductive layer, and wherein the electro-migration inhibiting plugs comprise a different material than the first electrically conductive material; and

planarizing the plugs so that surfaces of the plugs and the planar surface are substantially co-planar; and

removing portions of said conductive layer to define electrically conductive segments interconnecting said plugs, each said plug separating neighboring segments by a distance that is small compared to the length of a segment.

Claim 33. (previously presented) The method of claim 32 wherein the electromigration-inhibiting material defines a liner in each of said windows, said liners being filled with an electrically conductive material to form said plugs .

Claim 34. (previously presented) The method of claim 32 wherein the electromigration-inhibiting material is selected from the group consisting of Ti, W, TiN, TiW, Mo and Ta.

Claim 35. (previously presented) The method of claim 32 wherein the electromigration-inhibiting material includes a refractory metal.

Claim 36. (previously presented) The method of claim 32 wherein the first electrically conductive material is selected from the group consisting of Al, Cu, Au, Ag and their alloys.

Claim 37. (previously presented) The method as recited in claim 32, wherein said plugs are wider than widths of said electrically conductive segments.

Claim 38. (previously presented) The method as recited in claim 32, wherein said plugs are at least as wide as the widths of said electrically conductive segments.